

OPA (SC-28) CD-3a Review Summary

Department of Energy/Office of Science Review of the Muon to Electron Conversion (Mu2e) Project

REVIEW DATE: **June 10, 2014**
 LOCATION OF PROJECT: **Fermi National Accelerator Laboratory**
 PROGRAM MANAGER: **Ted Lavine**
 FEDERAL PROJECT DIRECTOR: **Pepin Carolan**
 ACQUISITION EXECUTIVE: **Patricia Dehmer**
 CURRENT CRITICAL DECISION: **CD- 3a**

Mu2e Project Status – April 2014		
Project Type	Line Item	
CD-1	Planned: 4Qtr. FY 2012	Actual: 7/2/2012
CD-3a	Planned: 3Qtr. FY 2014	Actual:
CD-2/3b	Planned: 4Qtr. FY 2014	Actual:
CD-4	Planned: 3Qtr. FY 2021	Actual:
TPC Percent Complete	Planned: N/A	Actual: N/A
TPC Cost to Date	\$48M	
TPC Committed to Date	\$50M	
TPC	\$229.3M	
TEC	\$177.7M	
Contingency Cost (w/Mgmt Reserve)	\$60M	32% to go
Contingency Schedule on CD-4	18 months	20%
CPI Cumulative	N/A	
SPI Cumulative	N/A	

Mu2e Project Funding Profile (\$M) from the CD-1 Presentation

Fiscal Year	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	Total
OPC - R&D	0.5	0.5	1.0	5.0						7.0
OPC - Design	4.277	7.9	5.0							17.117
TEC - PED			24.0	20.0	5.0					49.0
TEC - Construction					20.0	25	42.4	45.5	23.1	156
Total Project Cost	4.777	8.4	30.0	25.0	25.0	25.0	42.4	45.5	23.1	229,177

1. SUMMARY

A Department of Energy/Office of Science (DOE/SC) CD-3a review of the Muon to Electron Conversion (Mu2e) project was conducted on June 10, 2014 at the DOE Germantown facility with FNAL participants via teleconference. The review was chaired by Kurt W. Fisher. The purpose of the review was to evaluate the project teams' readiness to request CD-3a to allow procurement of conductor for the remaining two solenoids. The request for CD-3a would allow

the Mu2e project team to utilize \$5.1 million for early procurement of the conductors for both the Transport Solenoid (TS) and the Production Solenoid (PS). The project team identified that the early procurement of the conductor could result in savings to the project of as much as \$6.0 million. In general, the Committee supported the request for procurement of the conductor and judged that the conductor design is technically sound and mature and the costs identified are credible.

2. TECHNICAL

The solenoid and conductor designs are based on previous applications of aluminum stabilized conductor and the technical risks are based on experience with constructing large magnets using this type of conductor. There are four distinct conductors required for the project and after more than a year of R&D, prototypes for each have been produced. The R&D strategy is to focus on developing high performance conductors in exchange for simpler solenoid designs, e.g., high current, low inductance, resulting in a simpler cooling scheme and simpler quench protection. The TS conductor is considered to be of moderate difficulty while the PS conductor is more challenging due to exposure to higher radiation levels and higher field operating requirement. The solenoids have been designed around the conductor and have passed a peer review that recommended going forward with the long lead procurement.

The TS conductor has met all specifications. The PS prototype met the critical current (I_c), bond and yield strength specifications with significant margin. However, it did not meet the geometrical tolerance or RRR specifications. The original specification of the Residual Resistivity Ratio was 600, which is considered very conservative. The intent is to compensate for accumulated radiation exposure that lowers the RRR and allow longer running time. The specification was re-evaluated and lowered to 500, which the vendor has been able to meet. This should have no impact on initial magnet training or performance and minor (if any) impact on the length of operation before requiring an anneal. The geometric tolerance can be met simply by tuning the dies. The project will require 100 m of PS prototype conductor and a full unit length prior to authorizing production.

Recommendation:

None.

3. COST and SCHEDULE, and MANAGEMENT

The Mu2e project team proposed a plan to utilize \$5.1 million for early procurement of the conductors for both the TS and the PS. This includes \$2.16 million for the TS, \$2.33 million for the PS, and 15% contingency at \$0.67 million.

The justification for this strategy is, in part, to take advantage of a schedule opportunity resulting in \$6 million in savings. The basis for this assumption is the early procurement will result in a reduction of the standing army by six months, which is approximately \$1 million per month.

In addition, the early start will alleviate some schedule pressure for both the TS and PS, which are both near the critical path, most notably the TS at one month. The expected production times required, at 12 to 14 months, are based off vendor quotes and experience with the prototypes.

With this schedule logic, the current critical path goes through the production of the conductor for the Detector Solenoid, which has already been granted early procurement.

The project team developed a risk register and presented a sample of eight risks associated with the solenoids. The register identifies a cost estimate and probability associated for each risk. Moreover, it identifies a cost estimate to implement the mitigation strategy associated with each risk.

As a partial response to lessons learned from the NSLS-II magnet procurements, the project team stated it has and will continue to meet with the vendors to ensure expectations and specifications are met. Additionally, if a culture of transparent communication is developed, the project team will be able to utilize the vendor's knowledge and historical experience to ensure that the design and production process are appropriate; thus reducing the risk of potential impacts to project performance.

The project team is utilizing an external solenoid advisory committee that includes expertise in key technical areas including magnets, conductor, and cryogenics. They are also using internal independent "off-project" expertise.

The Mu2e project team is supported by dedicated procurement/contracting specialists.

As it relates specifically to cost and schedule for the early procurement of the TS and PS conductors, there are no significant concerns. However, in an effort to mitigate risk, it is advisable to continue to work closely with the selected vendors to ensure technical specifications are met and schedule performance is communicated.

The requirement for the vendor to produce a 100 meter conductor prototype for the PS, prior to committing to a full production, is wise. This should provide insight to the vendor's ability to meet the schedule and, if necessary, develop schedule mitigation strategies prior to entering full production.

The project team stated that from historical data at Fermilab, 15% contingency is considered conservative for purchase orders; this seems appropriate considering the relatively low risk and limited scope.

The Committee supported the project team's plan for procurement/contracting resources continuing to be fully engaged in the conductor procurement, through production, and, for future project procurements. Also, it is critical to ensure proper technical oversight and quality assurance at the vendors.

The Committee recommended that the project team develop a plan to evaluate and, where possible minimize logistical and technical interfaces/interdependencies of the various components within the project.

Recommendation:

None.

DOE F 1325.8
(08-93)


United States Government

Department of Energy

memorandum

DATE: MAY 28 2014

TO: Stephen Meador, Acting Director, Office of Project Assessment, SC-28

FROM: Michael Procario, Director of Facilities for High Energy Physics 

SUBJECT: DOE Review of the Mu2e Project

I request your Office organize and conduct an Office of Science Independent Project Review (IPR) on June 10, 2014 in Germantown Headquarters for the Mu2e Project. The primary purpose of this review is to evaluate the project's readiness for approval of Critical Decision CD-3A, Approval of Long-lead Procurement, for the project's solenoid magnet superconductor. The review committee should also assess the project's direction toward developing the performance baseline by the end of the fiscal year.

Specifically, the committee should respond to the following questions:

1. Are the conductor designs technically sound and sufficiently mature, and are all requirements and technical risks appropriately defined in order to support conductor production?
2. Is the project being effectively managed, and is it properly organized and staffed to successfully execute the project plan as it relates to the long-lead procurement?
3. Are the cost and schedule for the long-lead procurements credible, with adequate contingencies? Are risks identified and managed appropriately?
4. Are environmental, safety and health aspects being properly addressed appropriately?
5. Has the project responded appropriately to recommendations from the last DOE review, specifically, in relation to the conductor?
6. Is the project ready for approval of CD-3A to start the long-lead procurement of the conductor?

Dr. Theodore Lavine is the HEP program manager for the Mu2e Project and will serve as the HEP contact person for the review.

We appreciate your assistance in this matter. As you know, these reviews play an important role in our program. I look forward to receiving your Committee's report.

cc:

M. Weis, FSO
P. Carolan, FSO
P. Philp, FSO

P. Dehmer, SC-2
J. Siegrist, SC-25
M. Procario, SC-25
T. Lavine, SC-25
K. Fisher, SC-28

Nigel Lockyer, FNAL
Greg Bock, FNAL
D. Hoffer, FNAL
R. Ray, FNAL

**Department of Energy/Office of Science CD-3a Review of the
Muon to Electron Conversion Experiment (Mu2e) Project
June 10, 2014**

REVIEW COMMITTEE PARTICIPANTS

Department of Energy

Kurt Fisher, DOE/SC

Review Committee

Steve Gourlay, LBNL
Peter Wanderer, BNL
Steve Meador, DOE/SC
Tim Maier, DOE/SC
Kurt Fisher, DOE/SC

Observers

Mike Procario, DOE/SC
Ted Lavine, DOE/SC
Alan Stone, DOE/SC
Pepin Carolan, DOE/FSO

**Department of Energy / Office of Science Review of the
Muon to Electron Conversion Experiment (Mu2e) Project
June 10, 2014**

Phone call-in Number: 202-287-6245

AGENDA

Tuesday, June 10, 2014—GTN Room Z-231

9:00 am	DOE Committee Executive Session	Meador
9:15 am	Project Status and CD-3a Readiness	Ray
10:10 am	Break	
10:30 am	Conductor Design and Requirements	Lamm
11:30 am	R&D Conductor Performance and Production Readiness	Lombardo
12:30 pm	Working Lunch	
1:30 pm	Committee Q&A with Project Team (if needed)	
2:00 pm	DOE Committee Executive Session	
3:00 pm	Break	
3:15 pm	DOE Committee Executive Session (cont'd)	
3:30 pm	Closeout	
4:00 pm	Adjourn	